

CHROMOSOME NUMBER AND ITS SIGNIFICANCE IN *BATIS MARITIMA* (BATACEAE)

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THE SMALL AND VERY DISTINCT family Bataceae comprises two species of succulent halophytic subshrubs, widespread in littoral zones of the tropics and subtropics, with one species, *Batis maritima* L., found in the New World (and naturalized in the Hawaiian Islands) and a second species, *B. argillicola* van Royen, in New Guinea. The low-growing plants have opposite leaves and either distinctive conelike male or female inflorescences borne on separate plants or solitary, unisexual flowers borne on the same plant. The flowers are much reduced and tetramerous and are subtended either by bracts or by leaves in the case of *B. argillicola*, which has solitary flowers. The affinities of the very peculiar Bataceae have long puzzled botanists, and the family has been allied at various times with an unusually large and varied number of different groups (McLaughlin, 1959; Mabry & Turner, 1964). Most recently (Dahlgren, 1975; Goldblatt *et al.*, 1976) the family Bataceae has been placed with the Australian Gyrostemonaceae in the order Capparales, a treatment suggested mainly by chemical evidence; however, a relationship to the Gyrostemonaceae is strongly supported by pollen morphology. Determination of the chromosome number in the family was undertaken with the hope that this knowledge would contribute to an understanding of the relationships of Bataceae.

CYTOLOGY

Plants of *Batis maritima* collected in the wild were grown at the Missouri Botanical Garden. A potting medium of pure sand kept completely water-saturated proved suitable, and the plants grew rapidly, producing an abundance of roots.

Root tips were pretreated in 0.003M hydroxyquinoline for four hours, then fixed in acetic alcohol. After hydrolysis in 10% HCl at 60°C for five minutes, root tips were squashed in lacto-propionic orcein.

Batis maritima L. $2n = 22$, Belize, Belize City, tidal flats near St. Josephs College, *Dwyer* 12370 (MO); $2n = 22$, U.S.A., Florida, Hillsborough County near Apollo Beach, *Hilsenbeck & Hilsenbeck* 627 (USF).

The chromosomes of *Batis maritima* are fairly small, in the 1–2 μ m range, but were very clearly stained and well spread out by the treat-

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ment described above. The diploid number of $2n = 22$ is almost certainly correct for the species, although occasionally one or two satellite-like structures, which were about one-third the size of the smaller chromosomes and always located close to larger chromosomes, were observed. This confirms Fulcher's (1972) record of $n = 11$, a count unknown to me at the time this study was undertaken, and contrasts notably with Engel and Schmidt's (1972) count of $2n = 18$ for plants collected in Colombia. It seems probable that either Engel and Schmidt's count is only approximate or an error was made in the identification of their material. A request for the loan of the voucher to check the latter possibility has to date evoked no response.

DISCUSSION

The family Bataceae has been allied with such varied groups as Empe-traceae, Buxaceae, Polygonaceae, and Juglandaceae (McLaughlin, 1959), but the most serious consideration has been given to possible relationships with the Amentiferae, particularly Salicaceae (Wettstein, 1935), with the Centrospermae, notably Chenopodiaceae and Amaranthaceae (Hutchinson, 1959; Buxbaum, 1961; Takhtajan, 1969), and most recently with the order Capparales (Dahlgren, 1975).

Most modern phylogenetic treatments, however, have tended to stress the uniqueness of the family, placing it in its own order as did, for example, Melchior (1964), who placed the Batales between the Papaverales and the Rosales, and Cronquist (1968), who placed it between the Caryophyllales and Polygonales, the latter still implying distant affinities with the Centrospermae. Thorne (1968) also admitted the Batales to his Chenopodiiflorae; more recently (1973), however, he has indicated that he believes the order to be unrelated to Chenopodiiflorae, although he does not suggest an alternative relationship. Dahlgren (1975) assigned Bataceae to his Violanae, a superorder comprising Violales, Tamaricales, Salicales and Capparales, and he suggested placing the Bataceae either in the Capparales or in a separate order, the family in both cases being closely associated with the Australian Gyrostemonaceae. Dahlgren's treatment is supported by Goldblatt *et al.* (1976) mainly on the basis of chemical evidence.

Seen against this rather conflicting background, the chromosome number of $n = 11$ in *Batis maritima* appears to be highly significant, particularly with reference to the Centrospermae and the Salicaceae. The latter, with the distinctive base number of 19, is seen as an unlikely relative of the Bataceae, and any possibility of this relationship can be discounted in the light of much other evidence.

The most important base number in the order Centrospermae is 9 (Raven, 1976), and this is clearly basic in Phytolaccaceae and Chenopodiaceae, the latter frequently associated with *Batis*. Within the Centrospermae, higher base numbers occur in the Basellaceae ($x = 12, 11$) and Cactaceae ($x = 11$), while abundant aneuploidy in the Amarantha-

ceae, Portulacaceae, Nyctaginaceae, and Caryophyllaceae makes it difficult to ascertain base numbers. However, Bataceae, with $x = 11$, is clearly discordant with the group of families in the Centrospermae with which it is most often associated.

In the light of phytochemical studies (Chang & Mabry, 1973; Mabry & Turner, 1964) and recent palynological and ultrastructural evidence (Goldblatt *et al.*, 1976), the family Bataceae is now seen as almost certainly misallied with the Centrospermae. *Batis* has plastids containing normal starch grains in sieve tubes and not the peculiar so-called P-type sieve tube plastids of the Centrospermae (Behnke & Turner, 1971). Phytochemical data also support the exclusion of the Bataceae from the Centrospermae (Goldblatt *et al.*, 1976), with the discovery (Ettlinger *vide* Goldblatt *et al.*, 1976) of glucosinolates in the family.¹ This evidence provides support for Dahlgren's placement of *Batis* in the Capparales, together with the mustard oil families. In addition, *Batis* has very unusual pollen grains of a type unknown in the centrospermous families (Erdtman, 1952; Prijanto, 1970a) but very similar to that of the Gyrostemonaceae (Prijanto, 1970b).

The placement of *Batis* in or close to the Capparales (Violanae) apparently is supported by the chromosome data, $x = 10$ and 11 being common in this order and probably basic (Raven, 1976), while $x = 11$ or 12 is the most likely basic number in the Violales. Dahlgren associates Bataceae particularly with the Australian Gyrostemonaceae, which have been shown to have $n = 14$ (Keighery, 1975; Goldblatt *et al.*, 1976). These two families do not seem particularly closely related on either cytological or morphological grounds, having most notably very similar and unusual pollen grains (Erdtman, 1952; Prijanto, 1970a, 1970b; Nowicke, pers. comm.) which are strikingly discordant with the Centrospermae although also with most members of the Capparales (Erdtman, 1952; Nowicke, pers. comm.). The two families together, however, seem closely allied to Capparales on the basis of the occurrence of glucosinolates in both and myrosinase in *Batis maritima* (Schraudolf *et al.*, 1971; Wagenitz, 1975).

In summary, it can be said that the chromosome number of *Batis maritima* contributes to the weight of evidence excluding Bataceae from Centrospermae and Salicaceae. Similar base numbers occur in Capparales and in *Batis*, but the Gyrostemonaceae, suggested as the closest ally of Bataceae in a Capparalean alliance, has $x = 14$, and this in itself provides no support for the supposed relationship between Bataceae and Gyrostemonaceae. The number $n = 11$ in *Batis* is, however, consistent with basic chromosome numbers in Capparales and in the Violanae in general. Of course, the chromosome number of *B. argillicola* is still unknown, and until this is determined, no further conclusions can be drawn.

¹ *Batis* has been analyzed for betacyanins and betaxanthins, characteristic of many, but not all, centrospermous families (Mabry & Turner, 1964), but no trace of either was reported. The absence of these two pigments, however, indicates nothing in itself about the relationships of Bataceae.

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